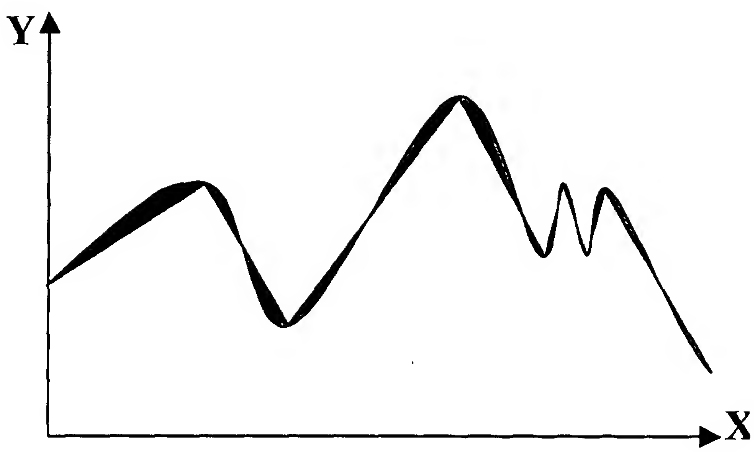
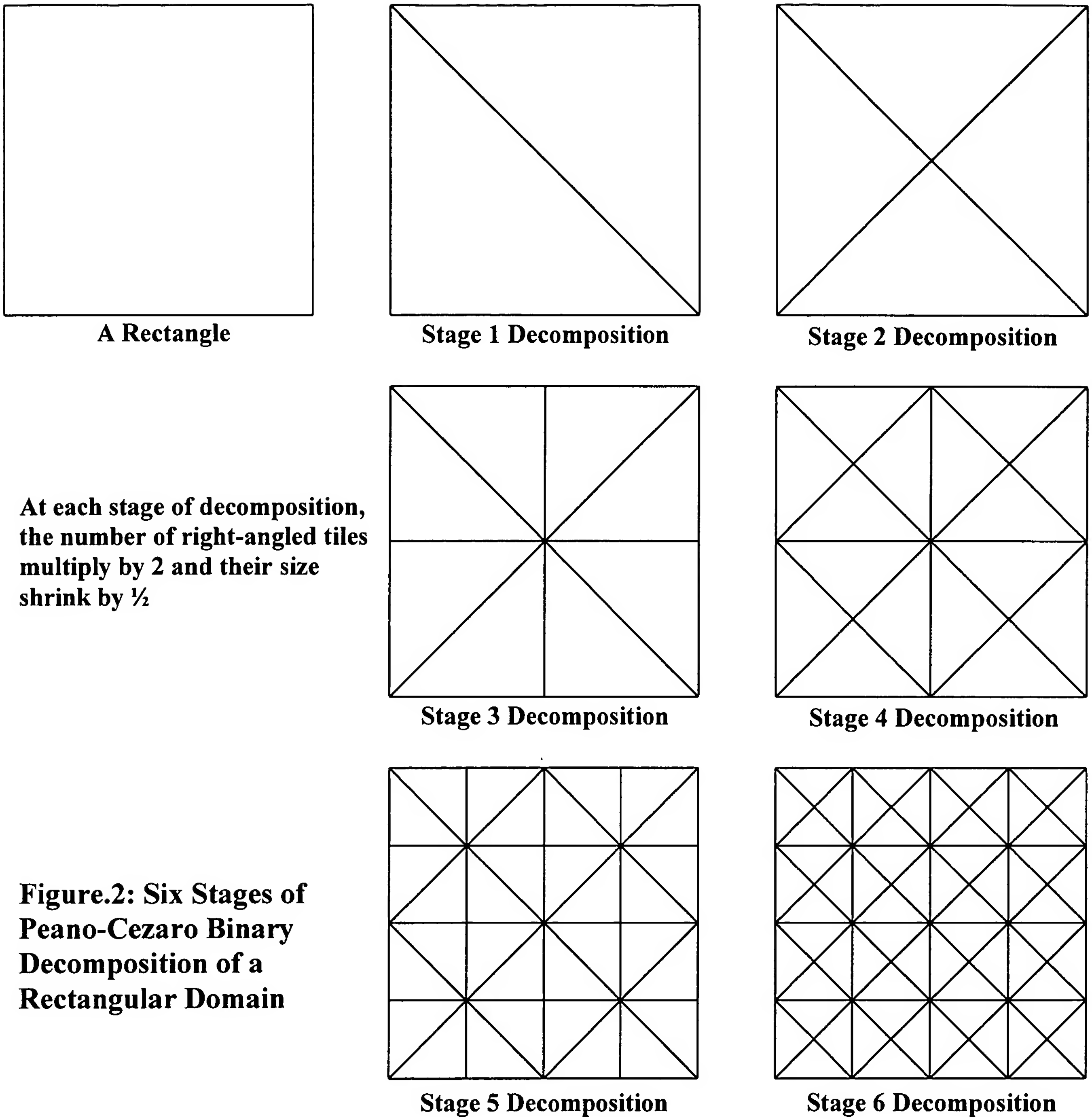


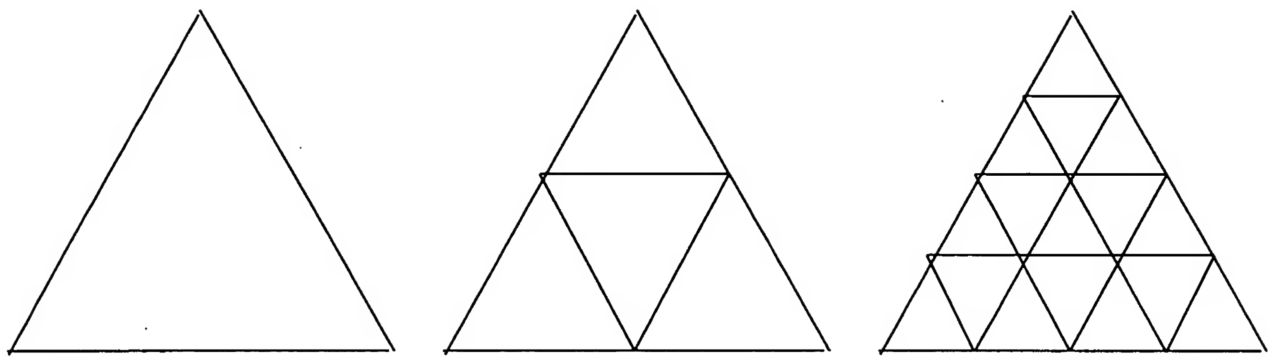
2-dimensional profile (in black) is *linearly* approximated by a sequence of joined lines (in red). Blue patches represent the error due to approximation.

Figure.1: A Linearization Procedure



At each stage of decomposition, the number of right-angled tiles multiply by 2 and their size shrink by ½

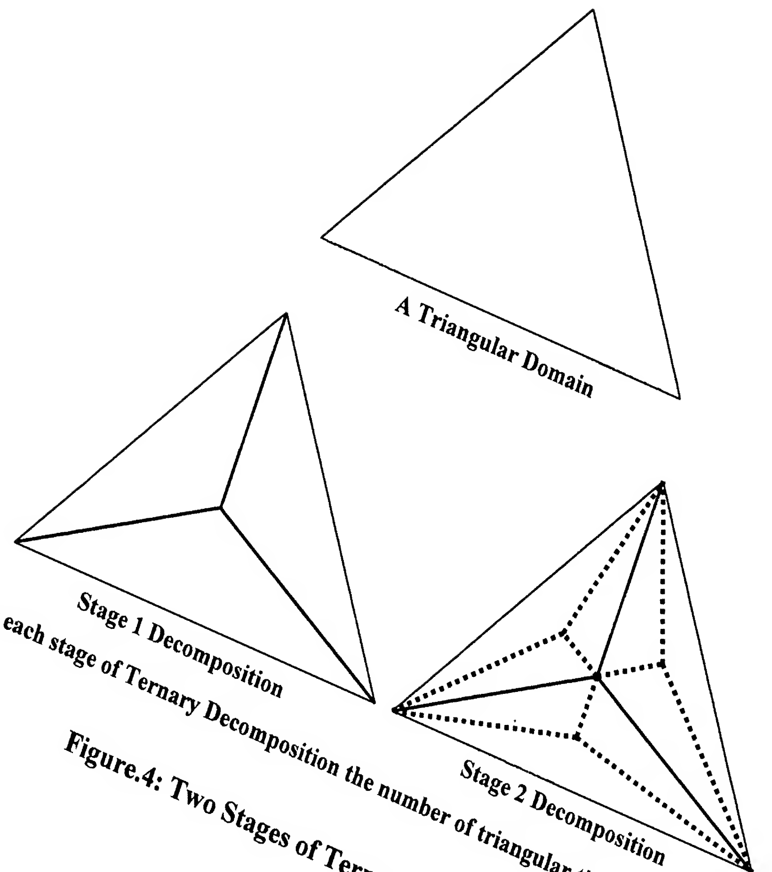
Figure.2: Six Stages of Peano-Cezaro Binary Decomposition of a Rectangular Domain



An equilateral triangle **Stage 1 Decomposition** **Stage 2 Decomposition**

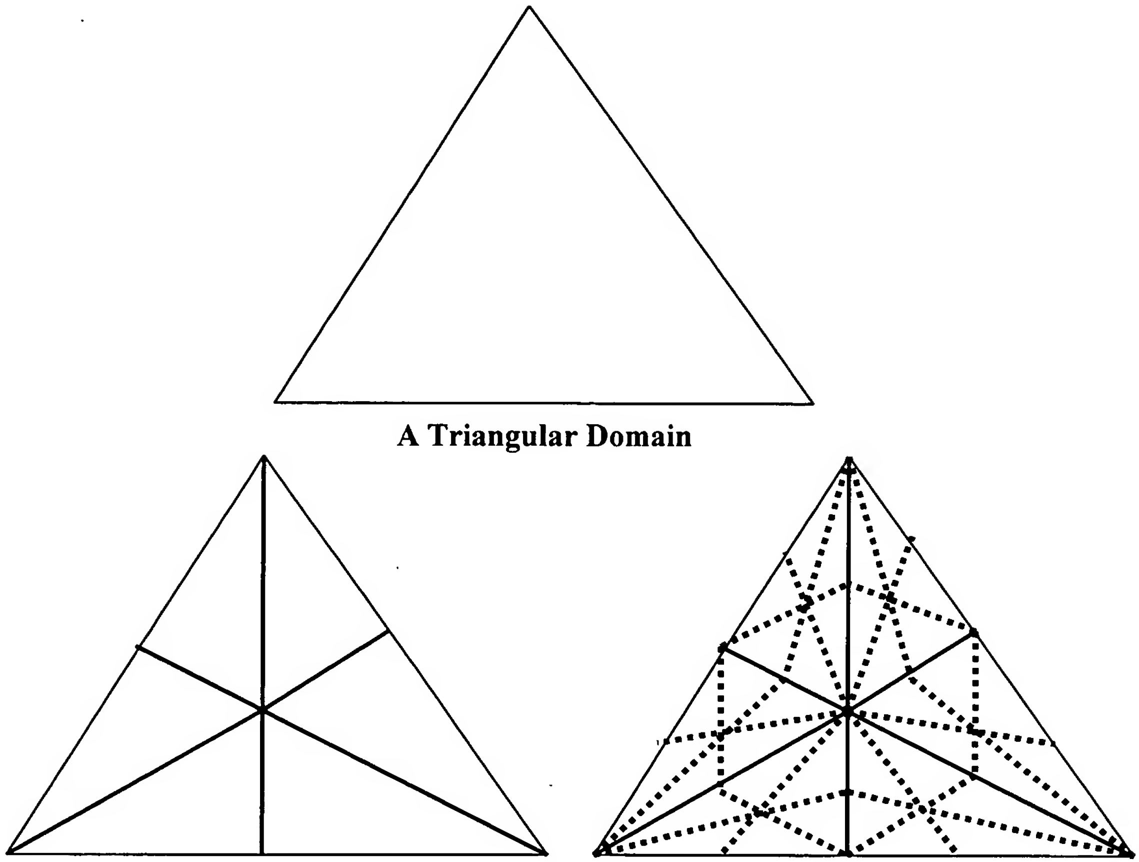
At each stage of decomposition the number of triangular tiles multiply by 4 and their size shrink by ¼

Figure.3: Two Stages of Sierpinski Quaternary Decomposition of an Equilateral Triangle



At each stage of Ternary Decomposition the number of triangular tiles multiply by 3

Figure.4: Two Stages of Ternary Decomposition



A Triangular Domain

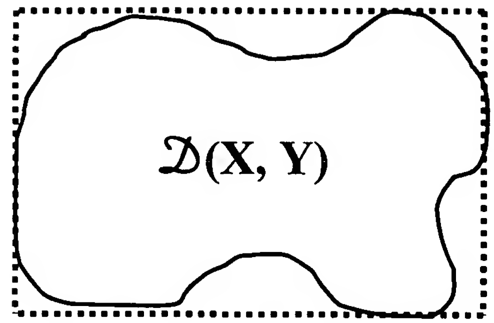
Stage 1 Decomposition

Stage 2 Decomposition

At each stage of Hex-nary Decomposition the number of triangular tiles multiply by 6

Figure.5: Two Stages of Hex-nary Decomposition

Figure.6: Circumscribing projected domain $\mathfrak{D}$(X, Y) with a rectangular hull



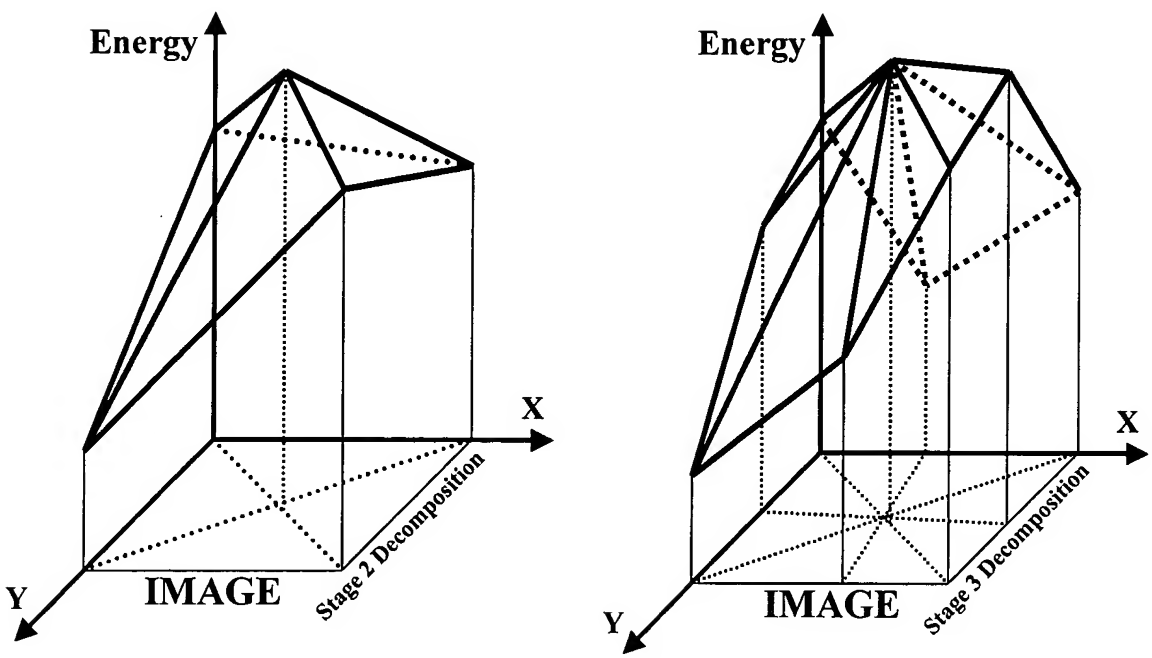


Image is in (x, y) plane. Triangular *perforated* tiles in (x, y) plane are projected into (Energy, x, y) space represented by *thickened* triangles. The vertices of thickened triangles touch the 2-dimensional image profile in (Energy, x, y) space not shown in the diagram. Thickened triangles model image profile.

Figure.7: Stage 2 and Stage 3, 3-dimensional tessellation of a hypothetical image profile in (Energy, x, y) space based on Peano-Cezaro decomposition scheme

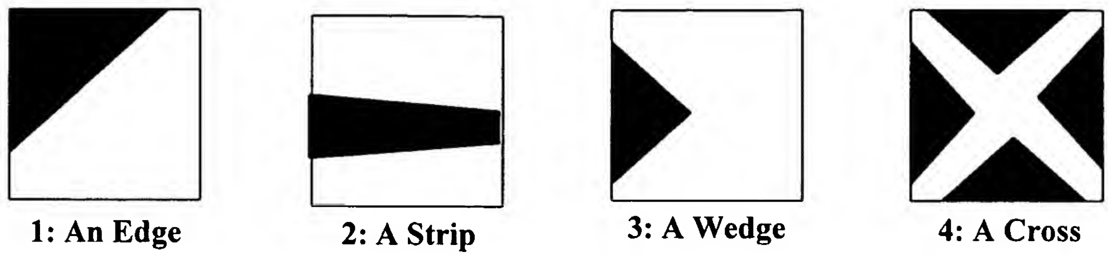


Figure. 8: Samples of canonical primitive image patterns

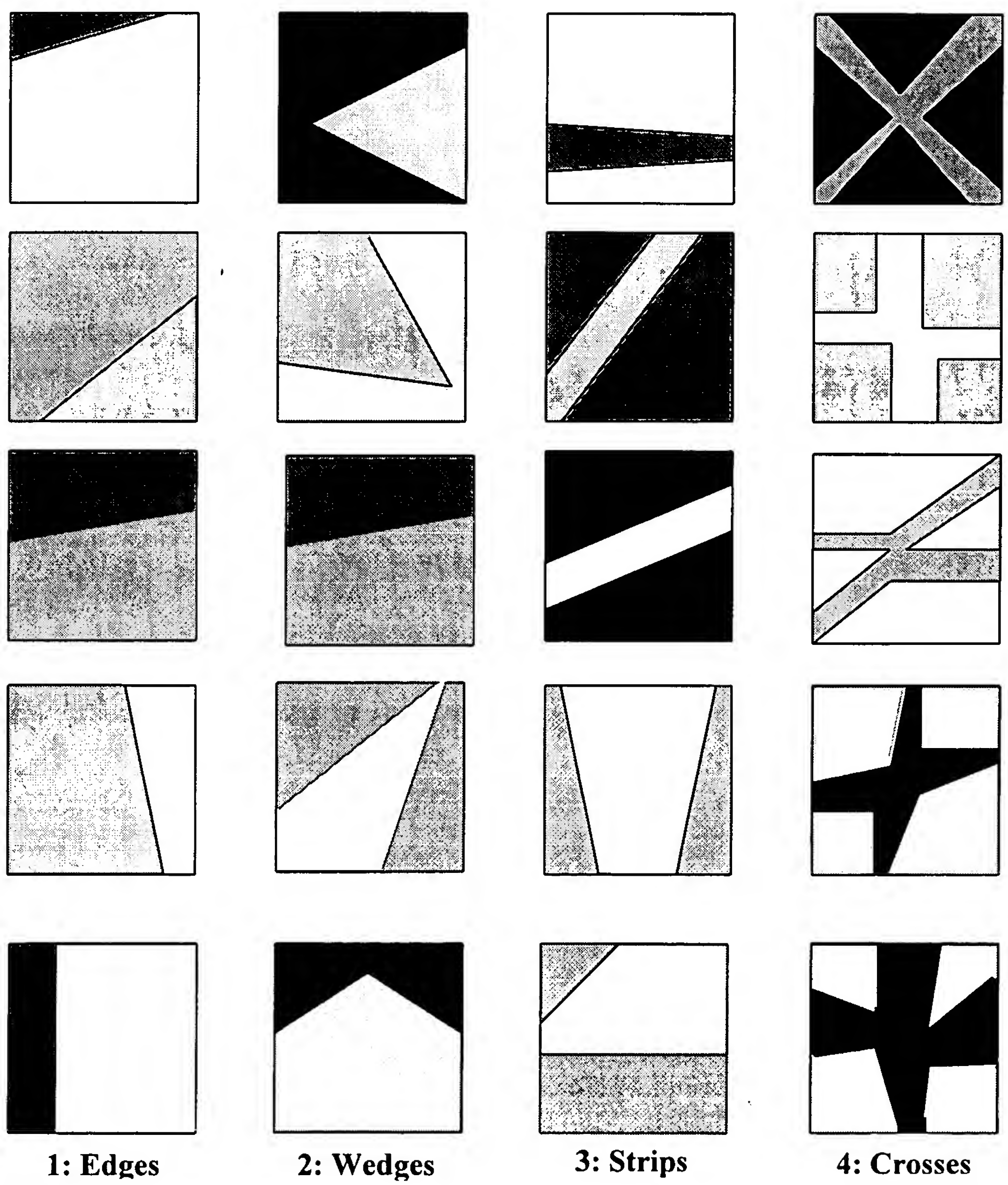
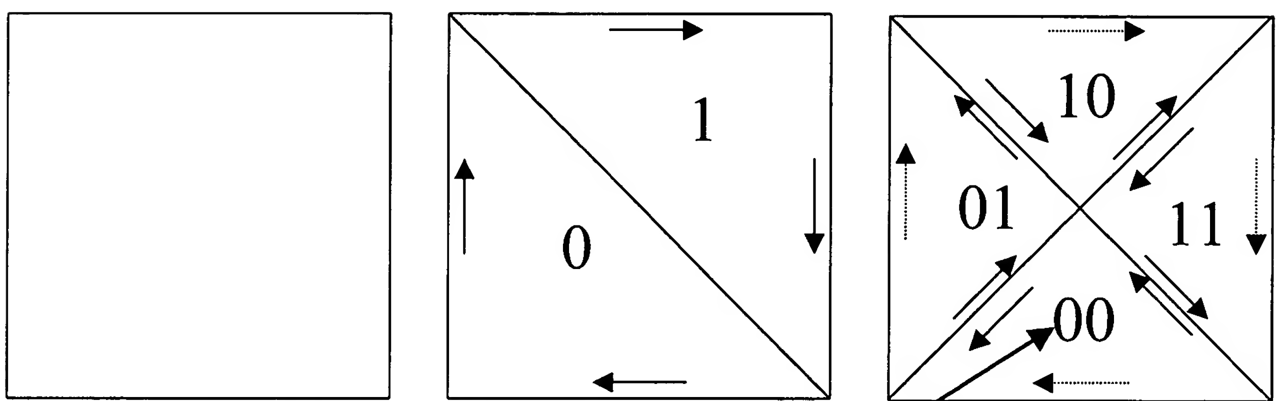


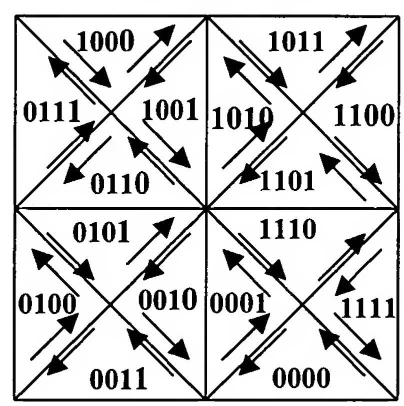
Figure.9: Samples of parametric primitive patterns



A Rectangular domain **Stage 1 Decomposition** **Stage 2 Decomposition**

Tile Binary Code Sequence

At each stage of decomposition, the number of right-angled tiles multiplies by 2 and their size shrink by ½. Solid arrows represent the order of tile sweep at current stage. Broken arrows represent order of tile sweep at preceding stage. A binary code sequence represents the inheritance relation of a tile to its ancestor tiles.



Stage 4 Decomposition

Figure.10: Four Stages of Peano-Cezaro Binary Decomposition of a Rectangular

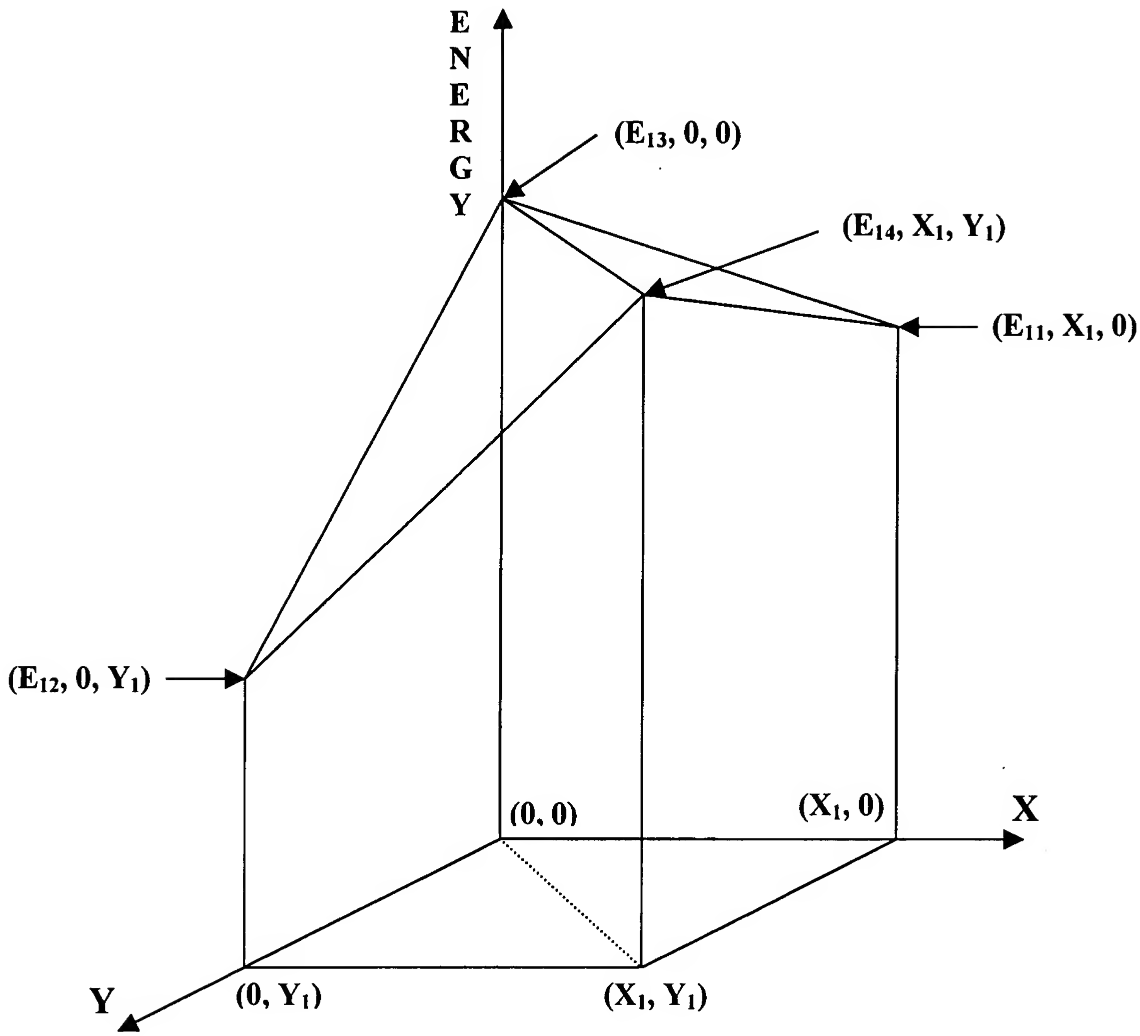
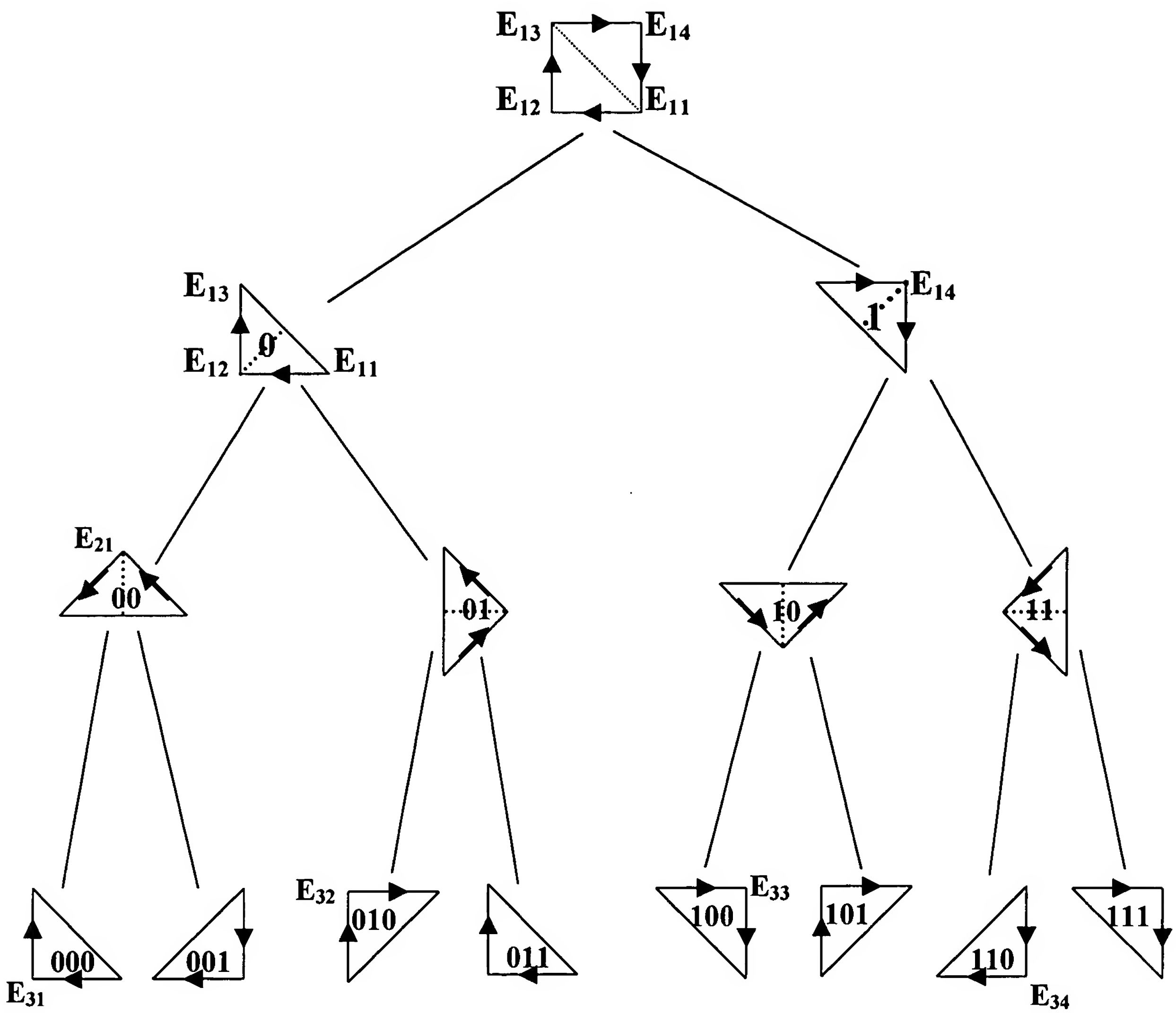
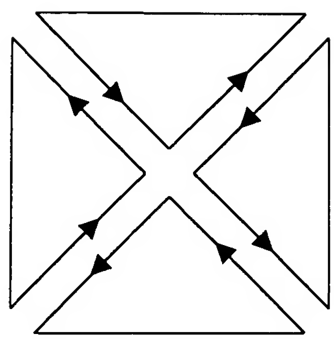


Figure.11: Stage 1 of 3D Tessellation Procedure

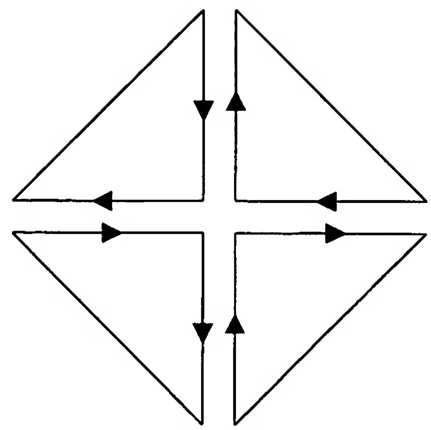


E_{11}, E_{12}, E_{13}, E_{14}, E_{21}, E_{31}, E_{32}, E_{33} and E_{34} represent energies at tile vertices. Broken lines represent the axis of decomposition. Bit values inside a tile represent a code sequence

Figure.12: Binary tree representation of Peano-Cezaro

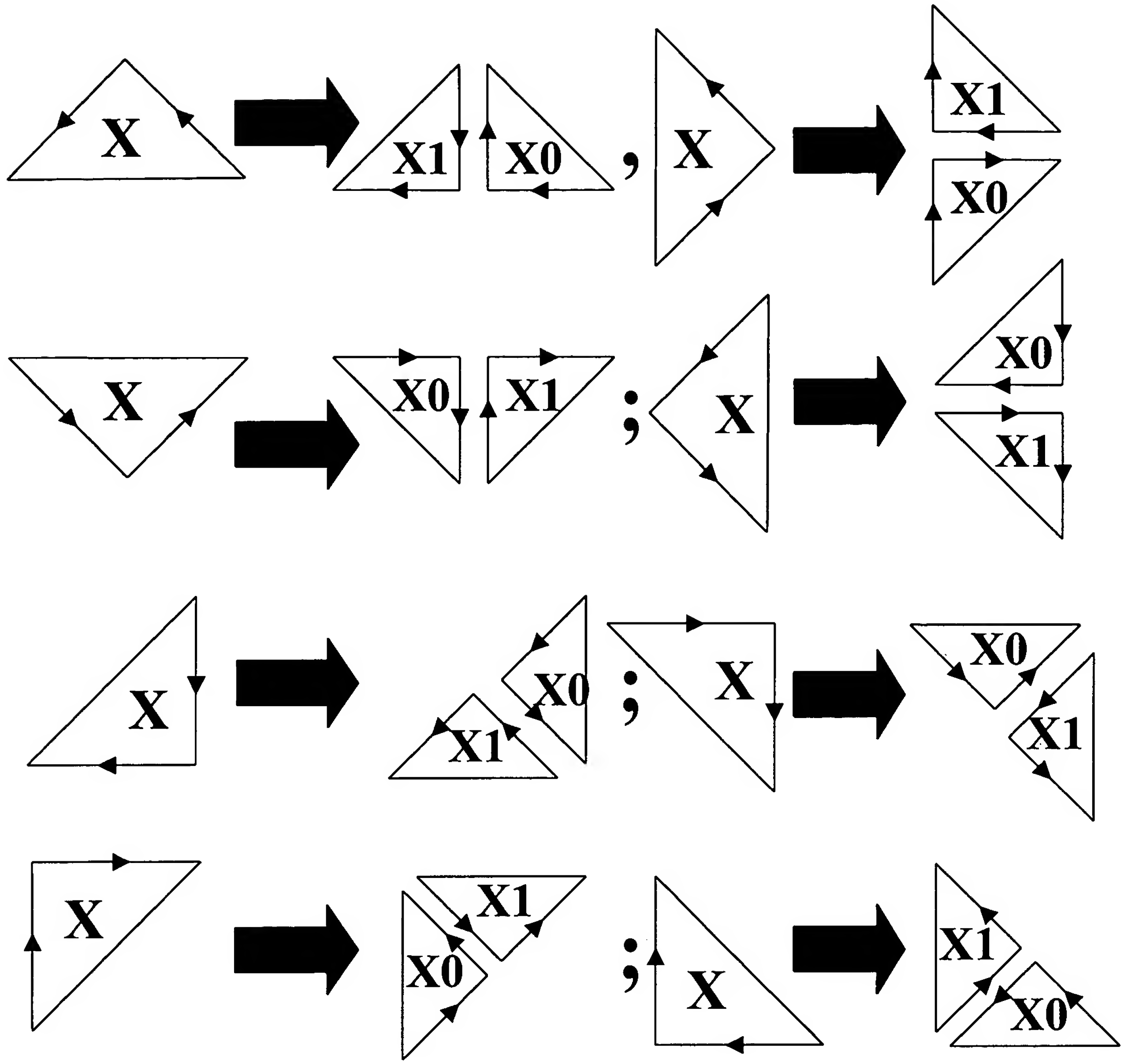


A: Even level tiles



B: Odd level tiles

Figure.13: Eight types of tiles divided into two



X is code sequence of tile before decomposition. X0 and X1 are code sequences of *children* tiles after decomposition.

Figure.14: Decomposition grammar for all eight types of tiles with bit assignments

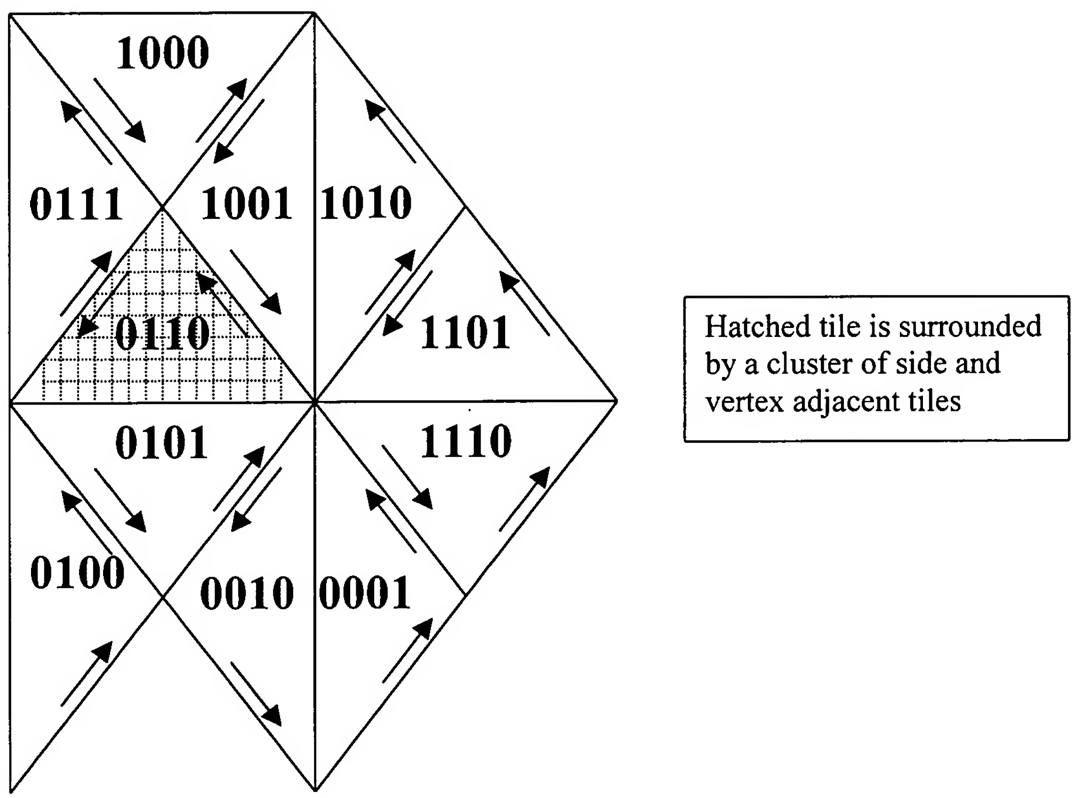


Figure.15:A cluster of side and vertex adjacent tiles

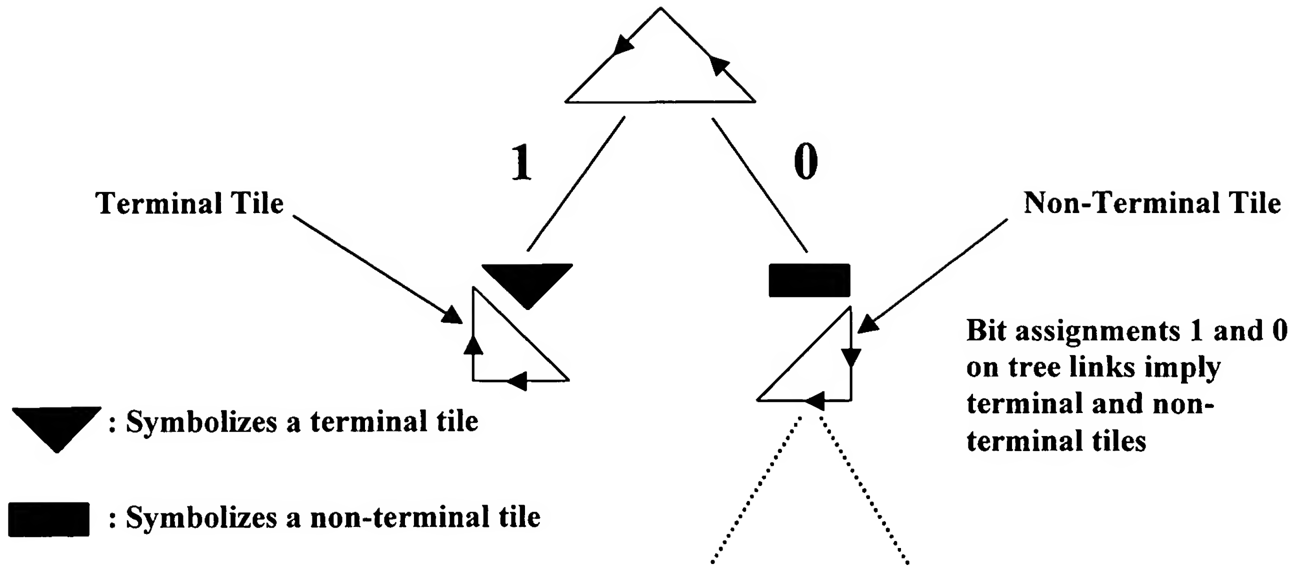
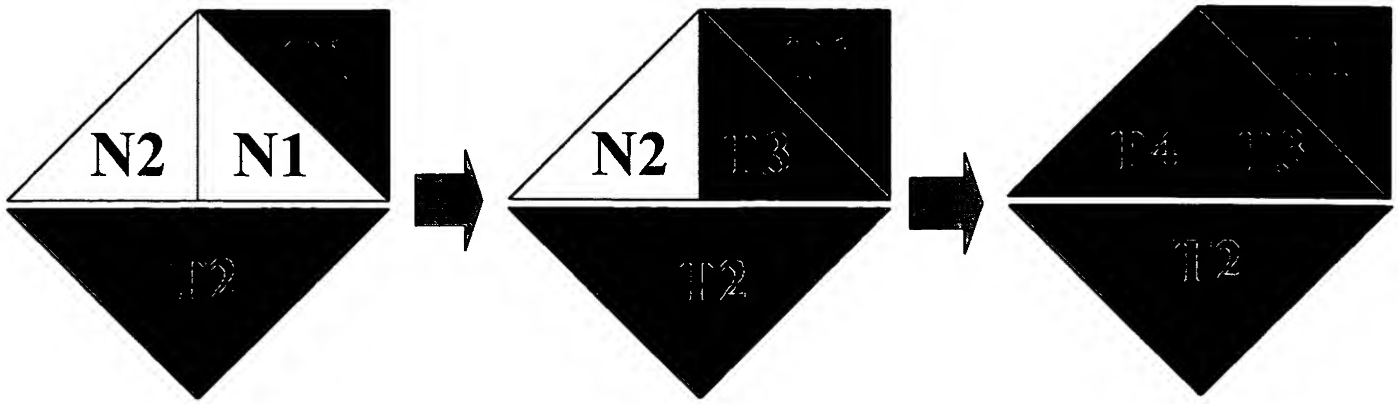


Figure.16: Fragment of a binary decomposition tree



(I) (II) (III)

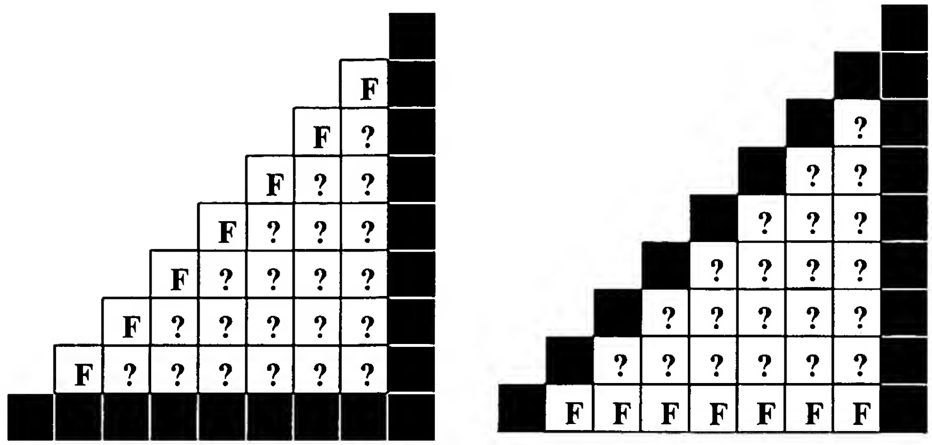
T1, T2, T3 and T4 stand for *modeled* terminal tiles in Filter 2. N1 and N2 stand for to-be-modeled non-terminal tiles in Filter 2. In state (1), non-terminal tile N1, being surrounded by more terminal tiles than non-terminal tile N2, has higher chance of being accurately modeled; hence, it has precedence over N2. In state (II), N2 is the only non-terminal tile left to be modeled. State (III) is the final

Figure.17: Tile state transition in Filter 2 processing

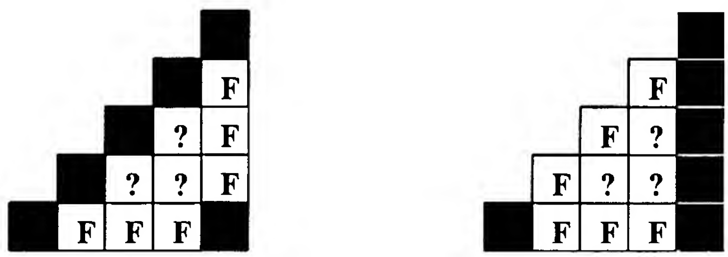
■ : Stands for an image site with known energy value

?: Stands for an image site with unknown energy value to be estimated using learning units

F: Stands for an image site with unknown energy value but whose primary features are extracted and used as input to the learning unit corresponding to tile structure



Two 9x9 size right-angled triangular structures



Two 5x5 size right-angled triangular structures

Figure.18: Four tile structures with right-angled side sizes 9 and 5

Application of classifier to energy values at the boundary sites of the tile in the diagram gives rise to partition of the set of energy values into three homologous sub-sets

Partition (79, 85, 93) is delimited by contour 1

Partition (131, 134, 137, 140) is delimited by contour 2

Partition (177, 180, 181, 182, 186) is delimited by contour 3

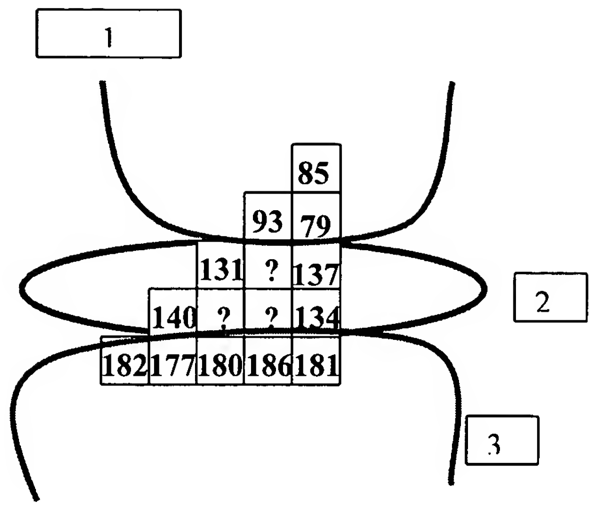
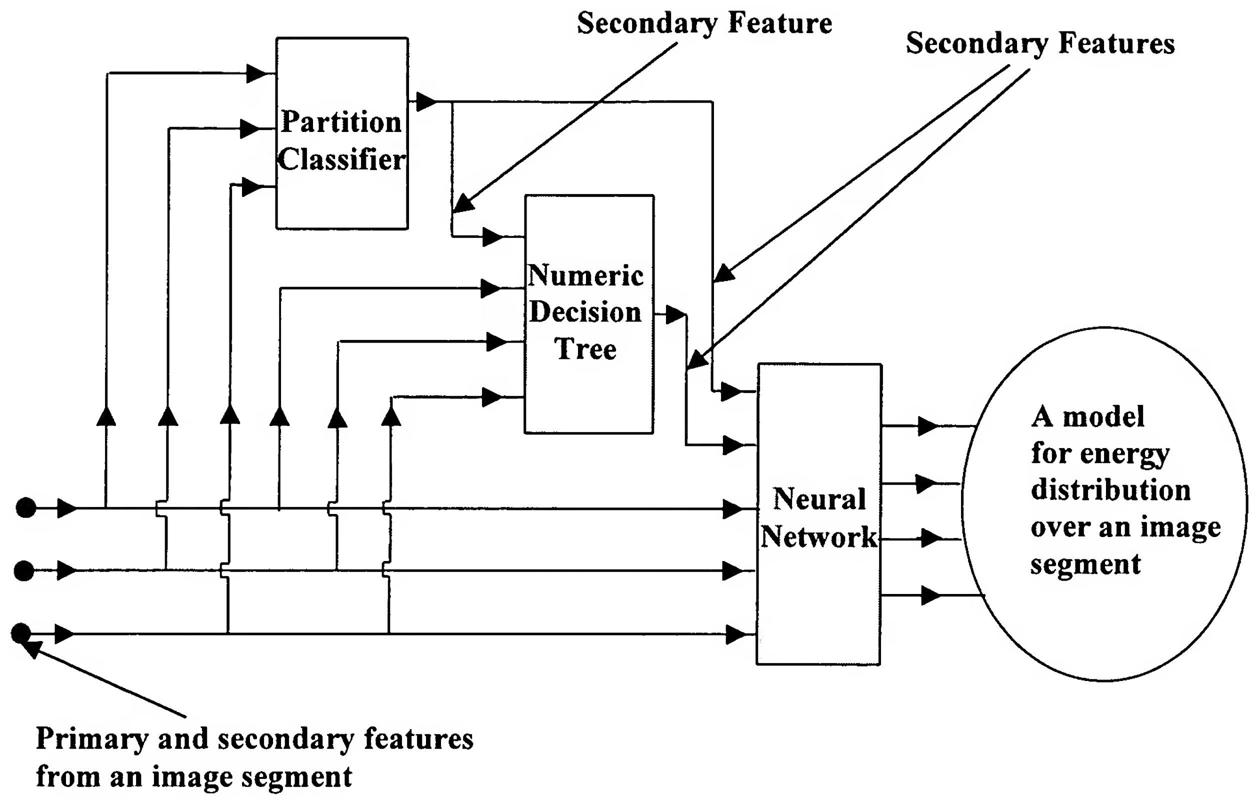


Figure.19: Partition of energy values using a classifier



A learning unit is composed of a classifier, a numeric decision tree and a neural network

Figure.20: A Learning Unit


: Stands for a site with known energy value

: Stands for a blank site with unknown energy value

A 3x2 size tile structure with one blank site. The *raw* energy value at the blank site is stored in Residual_Row

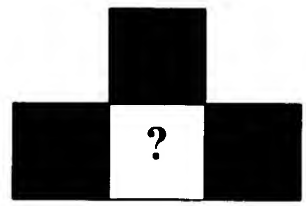
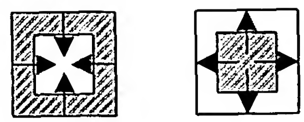


Figure.21: A miniscule tile structure with one blank site



A: Context to predict content

B: Content to predict context

Arrows show direction of prediction

Figure 22: Duality of **content** and **context**

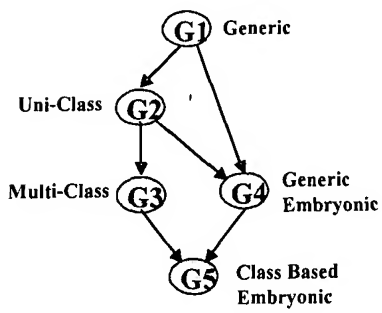


Figure 23: UC codec road map

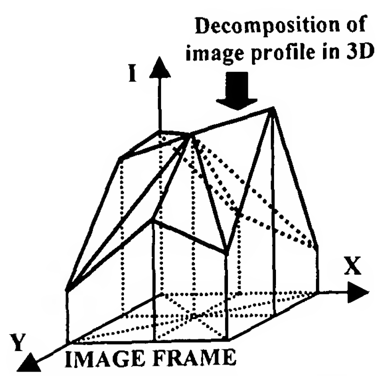


Figure 24: decomposition of image profile in 3D

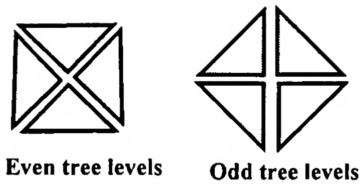


Figure 25: Binary quadratic

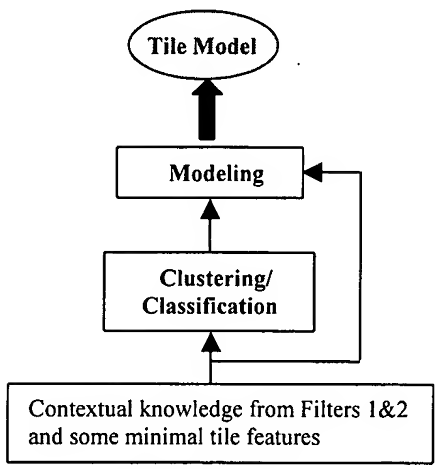


Figure 26: A learning

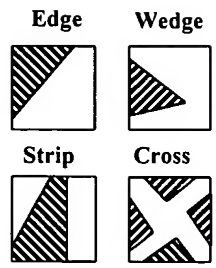
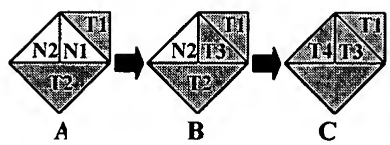


Figure 27: Primitive patterns



T1, T2, T3 and T4 are ***terminal*** tiles
N1 and N2 are ***non-terminal*** tiles

Figure 28: State transition in **Filter2**

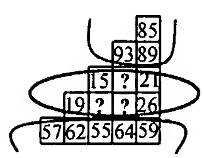


Figure 29: Clustering boundary intensities

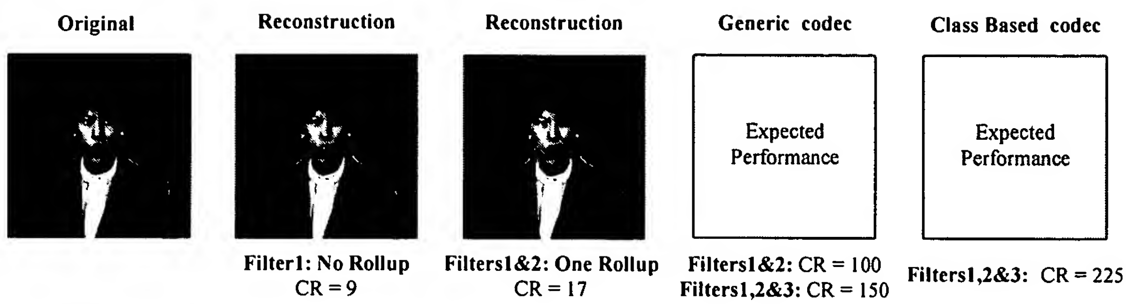


Figure 30: UC's Current and Expected Performances

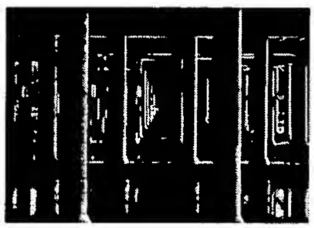


Figure 31: Pillars

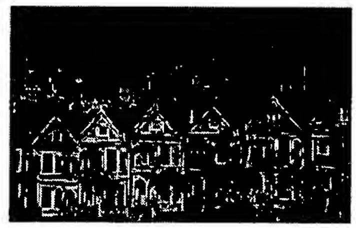


Figure 32: Town

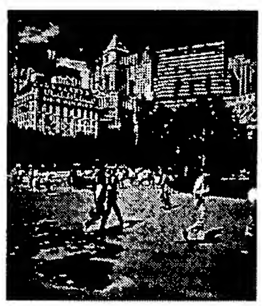
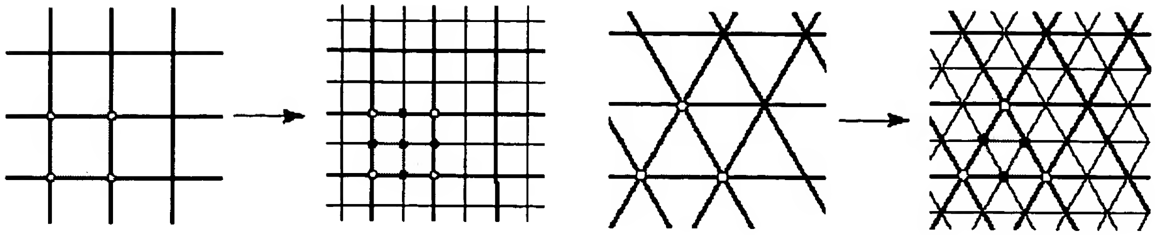


Figure 33: City Park

Figure 34: Waterfall



a: 2D quadrilateral quaternary decomposition

b: 2D triangular (Sierpinsky) quaternary decomposition

Figure 35: Subdivision rules for triangular / quadrilateral meshes

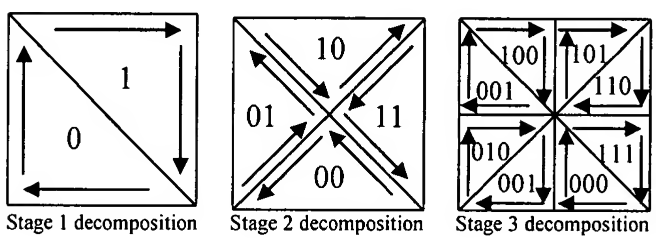


Figure 36: Three stages of decomposition

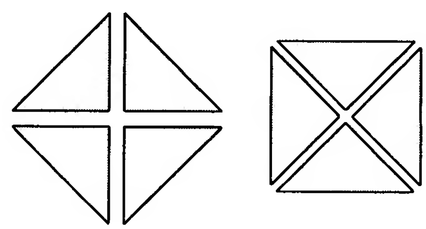


Figure 37: Eight tile types

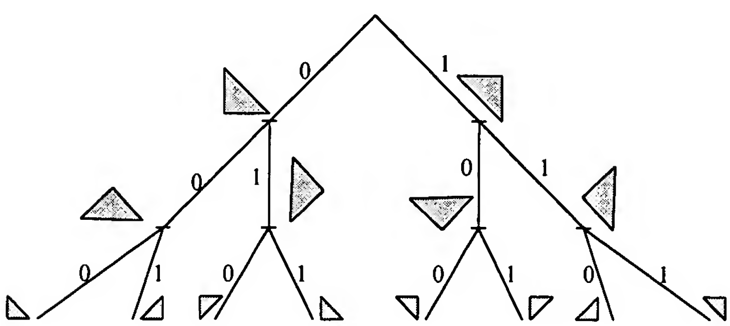


Figure 38: Tree representation of triangular decomposition

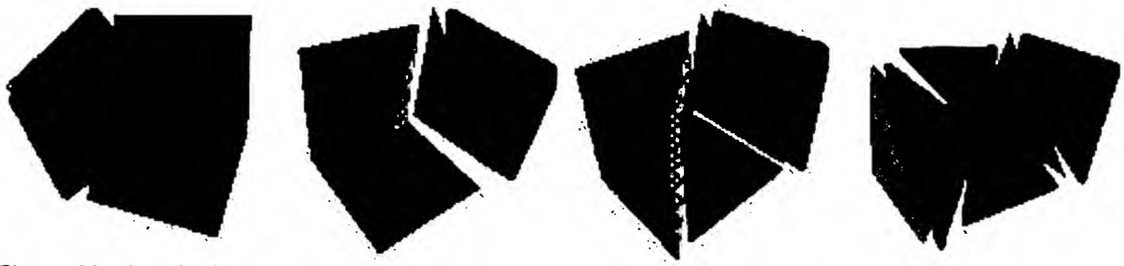


Figure 39: Standard unit-cube tetrahedral cover

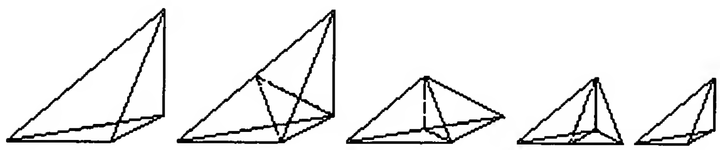


Figure 40: Decomposition of a tetrahedron by recursive bisection

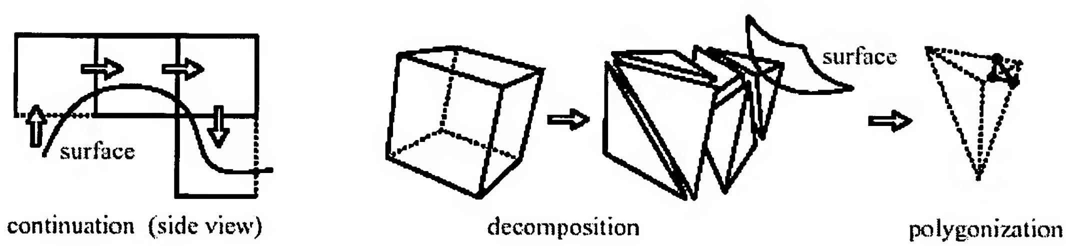
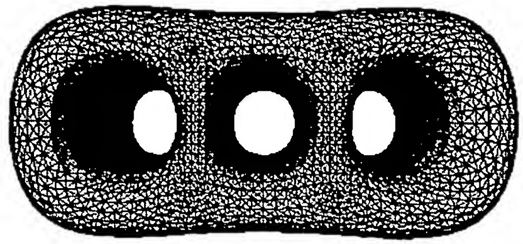
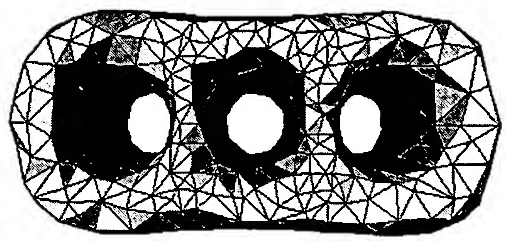


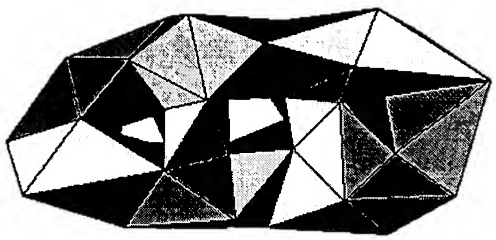
Figure 41: Overview of the mesh extraction procedure



a. Fine mesh at the smallest scale



b: Intermediate mesh



c: Coarsest mesh

Figure 42: Meshing at three different scales

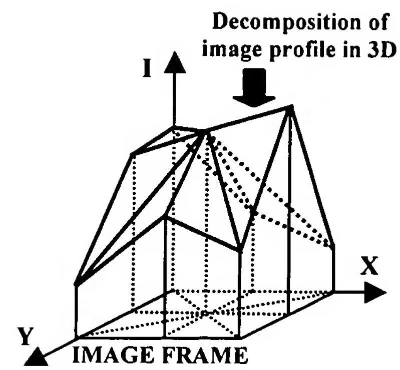


Figure 43: Decomposition of image profile in 3D

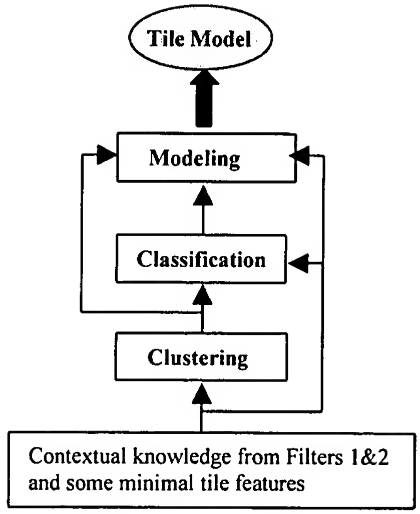
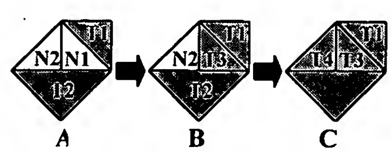


Figure 44: A learning unit



T1, T2, T3 and T4 are ***terminal*** tiles
N1 and N2 are ***non-terminal*** tiles

Figure 45: State transition in **Filter2**